O-09

Growth and domain structure control of PIN-PMN-PT single crystals

Z. Li, K. Song, H. Guo, M. Ma, S. Fan, Z. Xu

Electronic Materials Research Laboratory and Key Laboratory of Education Ministry and International Center for Dielectric Research, Xi'an Jiaotong University, Xi'an 710049, People Republic of China
e-mail: zhrli@mail.xjtu.edu.cn

Relaxor based ferroelectric single crystals $Pb(In_{1/2}Nb_{1/2})O_3$-$Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ (PIN-PMN-PT) with composition near morphotropic phase boundary exhibit extraordinary piezoelectric properties. In this talk, we will show recent development of PIN-PMN-PT single crystal researches in Xi'an Jiaotong University. (1) Large size single crystal boule with 108mm in diameter and 170mm in length was successfully grown by modified Bridgeman method. The excellent properties (d_{33}-2774pC/N, k_{33}-0.94, E_C-4kV/cm, T_C-180°C, T_{RT}-100°C) were found near the morphotropic phase boundary composition. (2) The uniformity of dielectric and piezoelectric properties of the crystal boules with 4" diameter by 100mm long were clearly modified and improved along the crystal growth direction by the Bridgman method. For 70% length of the boule, T_{RT} and Tc were around 100°C and 160-180°C along the growth direction， respectively. The variety of piezoelectric constant d_{33} is about 1500-1800pC/N in the same range of the boule. So that PIN-PMN-PT crystals will be more cost-effective and beneficial for ultrasonic applications in higher temperature region. (3) The domain size was controlled by field-cooling method in PIN-PMN-PT single crystals. The domain size was decreased to sub-micrometer (W_d=0.4μm) in [111]-oriented tetragonal rod PIN-PMN-PT crystal using field-cooling method, and the piezoelectric response tremendous increased (d_{33}=1630 pC/N). For the single domain [001]-oriented tetragonal rod PMN-PT crystal, the mechanical factor Q value is 2250. It was found that the piezoelectric property increase with domain size decrease and the mechanical factor increase with domain size increase. The function of relationship between domain size and piezoelectric property was obtained.